UNIVERSITY OF FLORIDA

MRI: Development of an Ultrabroad Bandwidth Source for Ultrafast Observation and Control of Physical, Chemical, and Biological Systems

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Highlights:
- Instrumentation Development at UF:
    - High repetition rate Ti:sapphire-based chirped pulse amplifier (CPA) with cryogenic cooling for thermal
- Current Capabilities
    - 30 fs time resolution
    - 1 mJ pulse energy
    - 5 kHz repetition rate
    - Spectral phase and amplitude control
    - Adaptive learning algorithm developed for coherent control experiments
- Human Resources and Outreach
    - Vidya Ramanathan (grad student); Jinho Lee (grad student); Ulai Noomnarn (undergraduate), David Pilkington (undergraduate), and Jayeeta Kundu (summer REU student)
    - Laser holographic 'Dinosaur exhibit' developed in New Physics Building as part of "Physics is Fun" set.
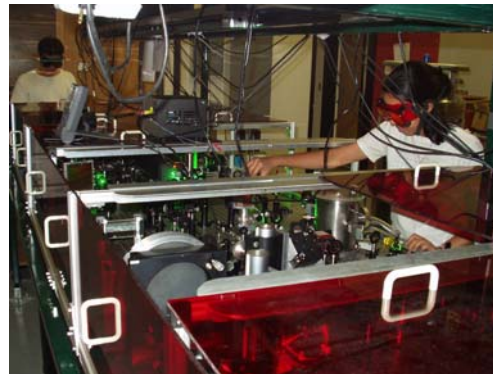
Vidya Ramanathan aligns the injection beam into the regenerative amplifier while **Jinho Lee** adjusts the pump laser power
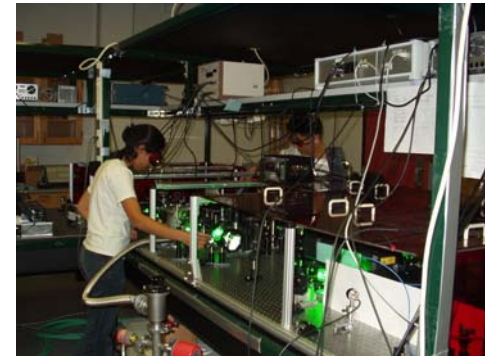
Vidya Ramanathan 'tweaking up' the regenerative amplifier power

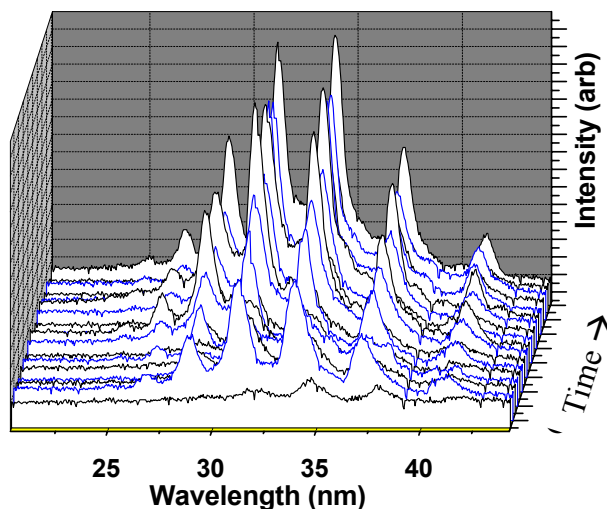Undergraduate **Brett Infanti** poses in front of the holographic dinosaur, 'Dino' .

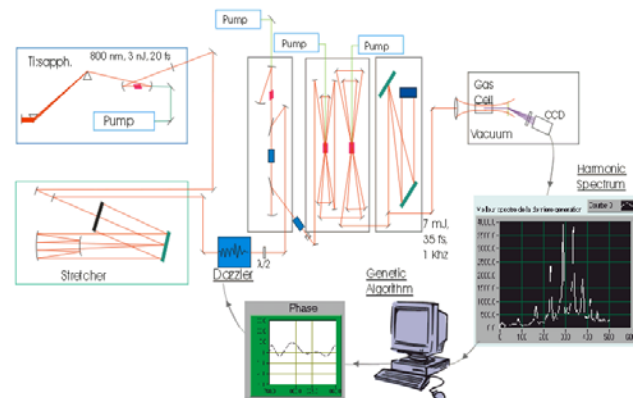**Ulai Noomnarn** computes the dispersion in a Ti:sapphire crystal

**Development of Adaptive Control Methods for Acousto-Optic Programmable Dispersive (AOPDF) Filters** –A "learning algorithm" has been been developed and tested on the AOPDF for controlling the amplified pulse spectral phase and intensity in adaptive control experiments. It has been tested in an experiment in which we have simultaneously tuned the wavelength and increased the efficiency of high order harmonic generation (HHG) for enhanced extreme ultraviolet (EUV generation) in the 20 – 40 nm band. (Work performed at Laboratoire d'Optique Appliquée in Palaiseau, France in collaboration with Philippe Balcou)

Schematic of the optimization experiment for enhancing EUV generation

The HHG spectrum versus time. As time progresses, the CPA 'learns' how to build the best laser pulse to increase the total energy of the harmonics producing the wavelength that the experimenter asked for!!
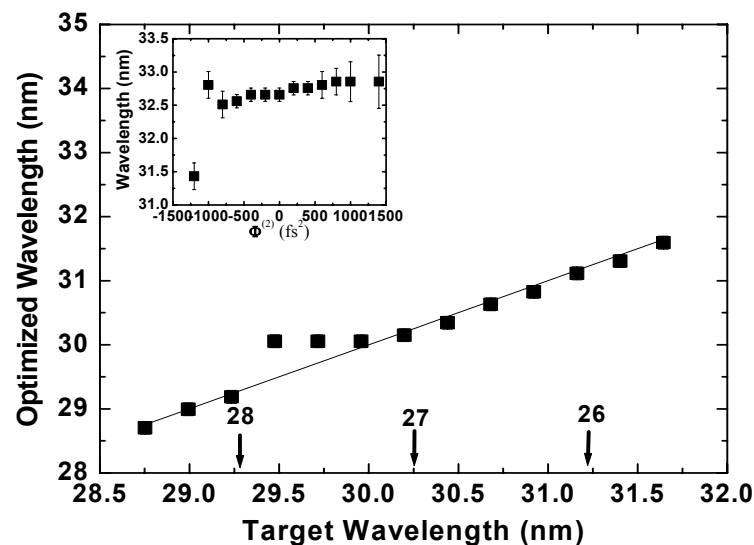
Tuning curve of the 27th harmonic via adaptive control. The line represents perfect tuning; arrows indicate the positions of the 26th, 27th, and 28th harmonics. Left inset: tuning curve obtained via chirping of the laser pulse.